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AUTHOR Grow-Maienza, Janice; Hahn, Dae-Dong; Joo, Chul-An
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ABSTRACT

A gap in mathematics achievement between Asian and American children is acknowledged on both sides of the Pacific. Previous comparative investigations have been undertaken in China, Taiwan, Japan and the United States to gain insight into possible relationships between classroom strategies and the acknowledged achievement differences. Asian children score consistently and significantly higher than American students on comparative mathematics achievement tests. The purpose of this study was to gain insight into mathematics instruction in primary schools in South Korea where no comparative studies of classroom instruction have been done, thereby providing yet another dimension to the international comparison of mathematics instruction in primary schools in Asia and America. For the present study mathematics instruction was observed in 20 classrooms in 5 primary schools in Pusan, South Korea. Using instruments developed for previous international comparative studies of mathematics instruction in primary schools, the researchers collected time-sampling observation data and narrative observation data on structures and strategies used in 10 first grade classrooms and 10 fifth grade classrooms. The data were analyzed for organizational structures in the classroom, for patterns of teacher and student behaviors, and for patterns of development of conceptualization in lessons. The results show sequences of highly organized and systematic patterns of instruction dominated by leading questions by the teacher and short student answers, often in choral response. The instructional sequences are followed by short periods of practice and evaluation. The results were compared to other international comparative studies and demonstrate that Korean classrooms have many characteristics similar to those in China and Japan, but other characteristics unique to Korea. The results have significant implications for those interested in mathematics instruction in both Asia and America. Contains 23 references. (Author)

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Mathematics Instruction in Korean Primary Schools
An International Collaborative Study

Janice Grow-Maienza
Truman State University
Kirksville, MO USA

Dae-Dong Hahn
Pusan National University
Pusan, Korea

Chul-An Joo
Pusan National University
Pusan, Korea

Handwritten signature: Janice Grow-Maienza

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Pusan National University
Pusan, Korea

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An International Collaborative Study**

**Janice Grow-Maienza
Truman State University
Kirksville, MO USA**

**Dae-Dong Hahn
Pusan National University
Pusan, ROK**

**Chul-An Joo
Pusan National University
Pusan, Republic of Korea**

To be presented at annual meeting,
American Educational Research Association
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June 1996

**Pusan National University
Pusan, Republic of Korea**

Mathematics Instruction in Korean Primary Schools An International Collaborative Study

Janice Grow-Maienza

Dae-Dong Hahn

Chul-An Joo

Janice Grow-Maienza is a Professor in the Master of Arts in Education program at Truman State University in Kirksville, Missouri, USA. She received her B.S. from Saint Louis University, and her M.S.T. and Ph.D. from the University of Chicago. She writes in the area of curriculum and teacher education.

Dae-Dong Hahn is an Assistant Professor in the Department of Education at Pusan National University, Pusan, South Korea. He received his B.A. and M.A. from Seoul National University and his Ph.D. from the University of Wisconsin in the United States. He writes in the area of sociology of education.

Chul-An Joo is an Associate Professor in the Department of Education at Pusan National University, Pusan, South Korea, where he chaired the Department of Education from 1993 to 1996. He received his B.A. and M.A. from Seoul National University and his Ed.D. from Harvard University in the United States. He writes in the area of school administration.

Abstract

A gap in mathematics achievement between Asian and American children is acknowledged on both sides of the Pacific. Previous comparative investigations have been undertaken in China, Taiwan, Japan and the United States to gain insight into possible relationships between classroom strategies and the acknowledged achievement differences. Asian children score consistently and significantly higher than American students on comparative mathematics achievement tests. The purpose of this study was to gain insight into mathematics instruction in primary schools in South Korea where no comparative studies of classroom instruction have been done, thereby providing yet another dimension to the international comparison of mathematics instruction in primary schools in Asian and America.

For the present study mathematics instruction was observed in twenty classrooms in five primary schools in Pusan, South Korea. Using instruments developed for previous international comparative studies of mathematics instruction in primary schools, the researchers collected time-sampling observation data and narrative observation data on structures and strategies used in ten first grade classrooms and ten fifth grade classrooms. The data were analyzed for organizational structures in the classroom, for patterns of teacher and student behaviors, and for patterns of development of conceptualization in lessons. The results show sequences of highly organized and systematic patterns of instruction dominated by leading questions by the teacher and short student answers, often in choral response. The instructional sequences are followed by short periods of practice and evaluation. The results were compared to other international comparative studies and demonstrate that Korean classrooms have many characteristics similar to those in China and Japan, but other characteristics unique to Korea. The results have significant implications for those interested in mathematics instruction in both Asia and America.

Mathematics Instruction in Korean Primary Schools

An International Collaborative Study

Background and Rationale

Cross national comparisons of mathematics achievement in the last fifteen years have consistently shown differences in favor of Asian students (Husen, 1967; McKnight, Travers, Crosswhite, and Swafford, 1985a and 1985b; Horvath, 1987). In the Third International Study of Science and Mathematics Achievement, Korean eighth grade students ranked second behind Singapore in mathematics achievement; United States eighth grade students ranked 28th in mathematics achievement in the survey of 41 countries (U.S. Department of Education, 1996). South Korean students in an earlier study ranked the highest mean scores in science and mathematics in the International Assessment of Educational Progress (IAEP) administered by the Educational Testing Service to 13-year-olds in 19 countries (Sorensen, 1994). It is also well documented that Asian students are acquiring a better understanding of mathematics than do American children, starting even at kindergarten, with significant gains at first grade, and even more gains at fifth grade (Miura and Okamoto, 1986; Stigler, Lee, and Stevenson, 1987). Korean children, in particular, have a very early understanding of the base 10 number system (Miura, Okamoto, Kim, Chang, Steere, and Fayol, 1994).

Differences have been attributed to variations in home and school experiences, including time devoted to mathematics instruction (Stigler and Perry, 1986; Westbury, 1992), and superior mathematics instruction (Schaub and Baker, 1991; Stevenson, Stigler, Lee, and Lucker, 1985; Stevenson, Stigler, Lucker, Lee, Hsu, and Kitamura, 1987; Stigler, 1988; Stigler, Lee, Lucker, and Stevenson, 1982; Stigler, Lee, and Stevenson, 1987; Lee, Graham, and Stevenson, 1996). One group of researchers based at the University of Michigan have investigated representative American, Japanese, and Chinese school populations in Minneapolis, Chicago, Sendai, Taiwan, and Beijing; the Michigan group have found differences not only in mathematics achievement, but also in parent attitudes, teachers' working conditions, and classroom strategies that have significant implications for relating achievement to mathematics instruction in classrooms (Lee, Graham, and Stevenson, 1996; Stevenson and Lee, 1995; Stevenson, Chen, and Lee, 1993; Stevenson, 1992; Stevenson and Stigler, 1992; Stigler and Stevenson, 1991; Stigler, Lee and Stevenson, 1987; Stevenson, Stigler, Lucker, Lee, Hsu, and Kitamura, 1987; Stevenson, Stigler, Lee and Lucker, 1985; and Stigler, Lee, Lucker, and Stevenson, 1982).

No comparative study of mathematics instruction in Korea was found in the extensive review of the literature for the present study. Yet Korean students score among the highest in mathematics and science on international comparative studies of educational achievement. The study reported here is a study of mathematics instruction in primary schools in five schools in Pusan, South Korea. Acknowledging lines of research today which focus on cognitive reasoning of both teachers and learners which will surely have many implications for primary mathematics instruction, the authors of this study have focused on observable class organization structures, student activities and teacher procedures in Korean classrooms. Organization structures refer to the way children are organized in classrooms during instruction--as one whole group, in a few or several small groups, or working individually.

The authors used instruments and followed procedures developed by researchers at the University of Michigan for that group's studies in Beijing, Taiwan, Sendai, Japan, Chicago, and Minneapolis (cited above). Authors of the present study have compared their results to the results of the Michigan group. No attempt has been made to compare the achievement of Korean students with those in China, Taiwan, Japan, or the United States, except to cite differences and ratings on international tests of achievement. The authors merely compare what was observed in mathematics instruction in classrooms in Korea with the observations reported in other countries by the Michigan group.

The previous investigations, reported in the various studies authored by Stevenson, Lee, Stigler, and others, cited above, were undertaken to gain insight into possible relationships between classroom strategies and the acknowledged gap in mathematics achievement seen between Asian and American children. Asian children score consistently and significantly higher than American students on comparative mathematics achievement tests. The purpose of this study was to gain insight into the mathematics instruction in primary schools in Korea where no comparative studies of classroom instruction have been done, and to provide yet another dimension to the international comparison of mathematics instruction in primary schools in Asia and America.

Authors of the present study acknowledge the cultural differences in Asian countries and in the West, and acknowledge differences in family values in Asian countries and in the West, any of which may be causal factors in the differences in mathematics achievement between Asian students and American students. However, the study here reported has focused only on the organization and strategies used in Korean mathematics instruction in classrooms to attempt to gain insight into classroom mathematics instruction in Korea. Results of the study show mathematics instruction in Korean classrooms to have many characteristics in common with Japanese classrooms, but also patterns which seem to be unique to Korea among other Asian classrooms investigated. Analysis of the data demonstrate coherence in lesson development and a high degree of student involvement in instruction. A pattern of leading questions/student answers/choral responses is evident in the data. Qualitative analyses of the narrative data from the study reveal ways in which students are thinking about mathematics, and ways in which teachers lead student thinking through the procedures--that is, there are patterns which reveal the conceptual development of lessons.

Findings from Previous Studies on Asian and American Classrooms

Many, perhaps most Americans view Asian education as teacher centered, children strictly disciplined, passively learning through rote memorization, missing out on those activities that promote creativity and problem solving skill. Many Asian teachers and graduate students with whom we have talked in Korea and China characterized American education as open and facilitative of creativity and problem solving skill in students. Many Asian students of education suggest that Asian classrooms should become more like American classrooms. Both of these stereotypes are gradually being challenged. The body of research begun at the University of Michigan where researchers have conducted a series of comparative studies in China, Taiwan, Japan and the United States report very different findings from the stereotypes described above (Lee, Graham, and Stevenson, 1996; Stevenson and Lee, 1995; Stevenson, Chen, and Lee, 1993; Stevenson, 1992; Stevenson and Stigler, 1992; Stigler and Stevenson, 1991; Stigler, Lee and Stevenson, 1987; Stevenson, Stigler, Lucker, Lee, Hsu, and Kitamura, 1987; Stevenson, Stigler, Lee and Lucker, 1985; and Stigler, Lee, Lucker, and Stevenson, 1982.)

The Michigan results on classroom strategies, for instance, indicate that teachers in Japanese classrooms demonstrate more whole class teaching, more coherence in lessons, more use of student problem solving, student explanations, and student errors than do teachers in American classrooms (Lee, Graham, and Stevenson, 1996). Children in Asian classrooms do less unsupervised seatwork than do children in American classrooms. Asian classrooms evidence fewer interruptions, and less unstructured and unsupervised student time than do American classrooms. (Lee, Graham, and Stevenson, 1996; Stevenson and Stigler, 1992; Stigler and Stevenson, 1991). The Michigan results show further that Asian lessons almost always begin with a practical problem or a word problem on the board, the entire lesson organized around the solution to one problem. The teacher leads the children to recognize what is known, and what is unknown, and directs the students' attention to critical parts of the problem. Students must explain the rationale for their solutions, and evaluate others' solutions. The teacher generally reviews at the end of the lesson that that has been learned, and relates it to the problem posed at the beginning. Stigler and Stevenson (1991) characterize Japanese classrooms thus:

Whole class instruction in Japan and China is a very lively, engaging enterprise. Asian teachers do not spend large amounts of time lecturing. They present interesting problems; they pose provocative questions; they probe and guide. The students work hard, generating multiple approaches to a solution, explaining the rationale behind their methods, and making good use of wrong answers (Stigler and Stevenson, 1991, 18).

Teachers in American classrooms, on the other hand, spend most of their time working with individual students and attending to matters of discipline. The shape of a coherent lesson is often hard to discern. Teachers get variety by shifting from one topic to another (e.g., a teacher may begin a lesson with a segment on measurement, proceed to a segment on addition, then to a segment on telling time, and then to a second segment on addition. After sending several students out of the room to band practice, report Stigler and Stevenson (1991), one teacher in an American classroom began the mathematics class

... with the remaining students by reviewing the solution to a computation problem that had been included in the previous day's homework. After this brief review, the teacher directed the students' attention to the blackboard, where the day's assignment had been written. From this point on, the teacher spent most of the rest of the period walking about the room monitoring the children's work, talking to individual children about questions or errors, and uttering "shushes" whenever the students began talking among themselves (Stigler and Stevenson, 1991, 15-16).

Stigler and Stevenson's descriptions of American classrooms ring true for many of us who spend much time in American classrooms. There is a burgeoning interest on both sides of the Pacific in the others' system of education. In America, the significant differences in mathematics achievement between American and Asian children is causing concern among many educators, even some parents. In Asian countries such as Korea, many young educators and students of education call for a western style "open education" that will develop problem-solving creativity in young students to meet the needs of 21st century post-industrialization and globalization. It is hoped the study reported here, in adding another dimension to the international comparison of mathematics instruction in primary schools in Asia and America, can provide insight to both Korean and American educators and students of education.

Procedures

Using the instruments developed by the Michigan group for their international comparative studies of primary classrooms in China, Japan, and the United States (Lee, Graham, and Stevenson, 1996; Stevenson and Lee, 1995; Stevenson, Chen, and Lee, 1993; Stevenson, 1992; Stevenson and Stigler, 1992; Stigler and Stevenson, 1991; Stigler, Lee and Stevenson, 1987; Stevenson, Stigler, Lucker, Lee, Hsu, and Kitamura, 1987; Stevenson, Stigler, Lee and Lucker, 1985; and Stigler, Lee, Lucker, and Stevenson, 1982), researchers of the present study collected data on the classroom structures and strategies used in ten first grade and ten fifth grade mathematics classes. Twenty primary classrooms in five schools in Pusan, Korea, were observed for one fifty-minute period each. The four classrooms in one of the five schools were observed more intensively--four times each for 50-minute periods. Thus, thirty-two mathematics lessons were observed, sixteen first grade lessons, and sixteen fifth grade lessons. Two first grade classes and two fifth grade classes were observed in each school. Results of the study were compared with results of the studies completed by Stevenson, Lee, Stigler and others in their group to add another international dimension to the growing literature on mathematics instruction in primary classrooms.

School Sample

In Korea, the population is not segregated by social class. Both public and private schools reflect a more heterogeneous population than do schools in America where neighborhoods are de facto segregated by social class. Private schools in Korea are regulated by the government as are public schools, and thus tuition costs are little more than in public schools. Unlike in America with its diverse curriculum which often has different goals for different students, schools in Korea have a national curriculum. All schools have common textbooks geared to that curriculum published by the government as in China. Students are

grouped heterogeneously, boys and girls mixed together, about 40 in a class in the primary schools.

An attempt was made to visit schools that would present a range in achievement scores of students, that is, schools that might be considered average, below average and above average measured by the socio-economic status of many families served by the school. One school, located near a densely populated "entertainment" area in Pusan, was characterized as having a high population of single parent families. Another school, where the administration claimed to be seeking to meet the needs of the two-working-parent families served by the primary school, sought to provide after-school homework supervision as is commonly done in the middle and high schools in Korea. A third school was characterized as having a higher number of children of professional families than the average.

There is an informal system of ranking schools by educational administrators in Pusan. The rank of schools is determined in the school by the local school board based on preferences of teachers, the socioeconomic status level of parents whose children attend the school, and commuting distances to and from the school for teachers. The latter criterion is no small issue in densely populated, traffic congested Pusan.

Below is a description of each of the five schools investigated. The descriptions were provided by the principal or head teacher in each school in an informal interview with one of the researchers. The school from which the case study for the analysis of narrative observation data for this paper was taken, had been ranked C, low in the hierarchy of A, B, C, D. According to the vice principal there, 35 percent of the parents in the school are salary workers, 43 percent are occupied in shop and sales, clerical jobs, or as craft workers. Only 10 percent of the parents are classified as unskilled workers, and 8 percent are characterized as firm owners, doctors, or lawyers. The educational level of fathers in general is high school graduate, the level for mothers middle school to high school graduate. Parent involvement in the schools was reported by the principal to be high, but financial support from both parents and local school board to be low.

In a second school in the sample, classified as a B school in the informal administrative bureaucracy, the socioeconomic status level of the parents is higher than average. Educational level of parents of children in the school is high school and above. Most families served by the school live in neighboring modern high rise apartments. Financial support from the local school board is high. A third school was classified as C but the head teacher there suggested the school should be upgraded to B because the population now served had higher incomes and cultural standards. Sixty percent of the parents live in apartment housing. These parents are viewed as more actively supporting their children's educations than those living in grounded small houses. It is in this school that a new centrally directed policy for establishing "open education" is being attempted in all grades by remodeling classroom structures. Teachers there are visiting other schools and studying the concepts and theory of "open education."

Socioeconomic status level of parents in a fourth school was characterized as lower-middle, but had a B rating because the traffic situation is relatively good due to its proximity to the nearby subway station. The school was characterized as an effective school by the researchers

due to what appeared to be high morale among the teachers, teachers' active engagement in schooling and the strong leadership of the principal. "Open education" was being initiated in the first and second grades the year of the study, and intensive English language study begun in the third grade. In a fifth school the socioeconomic status level of the working class families served by the school is below average. Parents are largely unskilled physical and mechanical workers and small merchants. Parent involvement reported by the principal is low. Just four percent - 50 out of 1200 parents - are involved in the schools. But the principal with whom we talked spoke knowledgeably and with passion about education, and was receiving a considerable amount of financial support from the local school board.

Instrumentation and Reliability

Two instruments were used for data collection, one involving a time-sampling procedure, the second a narrative description of everything seen and heard in the class related to the teacher and student. Two observers were in the room for every session. The first observer used the time sampling instrument to record for each minute of the lesson the presence of predetermined categories. Those predetermined categories described the organization of the classroom as a whole group, several small groups, or individuals working alone. Other categories classified the focus of attention on the teacher, a student or students, or other. Additional categories described several teacher and student behaviors, including question/answer sequences, the presence of evaluation by either teacher or students, and the mode in which mathematical concepts were developed--verbal, concrete, or numerical. Most of the categories with the means and standard deviations for first and fifth grades can be seen in Table 1 below. The second observer wrote a narrative description of everything she saw and heard in the classroom, noting particularly the times by a timepiece when there was a change in materials used, a change in teacher or student activities, or a change in topics being covered. Each of these changes was noted also by a line segmenting the narrative description. At the end of each observation session, observers coded on a third instrument their impressions of what they had observed according to a scheme that defined for the researchers coherence in the lesson. Coherence was determined by scores on a Likert scale for characteristics of connectedness, clarity and movement from simple to complex in the lesson.

To insure reliability, observations were conducted by selected graduate students, all enrolled in a research class at Pusan National University. The observers had sixteen hours of training with video tapes of classroom mathematics classes before conducting observations in classrooms. Reliability on the time-sampling instrument was determined to be established when the group had attained eighty percent consensus on scoring during training. Reliability on the narrative observation instrument was determined to be established during training when observers obtained 80 percent consensus on the number of segments drawn in given observation sequences. Segments were defined by changes in materials used, by changes in topic being addressed, or by changes in activities.¹

Analysis

The systematic observations gave us objective quantifiable data. Observers collected the data in Korean, later translated the narrative data into English. The data from the time-sampling

instrument were quantified and frequencies developed for each grade. Similarly, data coded for coherence on the third instrument were quantified. Data from the narrative observations were analyzed for patterns of classroom teacher strategies, for patterns of student behaviors, and for patterns in conceptual development of lessons. In reporting the results it has been useful to compare the data to data collected in other studies for which the instruments used were originally developed. Thus, we have compared the Korean data with data collected in China, Taiwan, Japan, and the United States. The results below are based on time-sampling data from 20 classes in five schools and on narrative data from the intensive case study of one school in which four classes were observed four times each for 50-minute periods.

At the beginning of the study in the fall, we had observed four classes in one school, two first grade classes and two fifth grade classes. Four 50-minute observations were conducted in each class. The initial analysis of the fall data demonstrated that the variance within the four observations of one class was very small. The Michigan group, whose instruments were used in this study, had found across schools variance to be much greater than within school variance in their studies of other Asian classrooms. Therefore, given the restraints of time and man power, we decided to broaden our sample and look at two first grade classrooms and two fifth grade classrooms in each of four new schools in the second phase of the study. Thus, we conducted in the spring one 50-minute observation in each of eight first grades and in each of eight fifth grades in four new schools.

For the analysis of the narrative data, we focused on those two first grade classes and two fifth grade classes in which we had conducted four fifty-minute observations in each class. An effort was made to determine, within the large sample of 10 first grade classes observed, the representativeness of the two first grade classes in which we had conducted four observations in each class. We computed the mean and standard deviation for each category on the time-sampling observation form for all ten first grades, the two observed four times each in the fall, and the eight observed once only in the spring. The descriptive statistics were derived from the averages of the four observations in each of the two first grades classes observed four times in the fall and summed with the eight observations of the classes observed in the spring. Similar procedures were conducted on the nine fifth grades on which we had data, two fifth grades observed four times each in the fall, seven fifth grades observed once each in the spring. (Data from one of the eight fifth grade classes observed in the spring were lost before analysis was completed). We computed summary variables for the ten first grade classes and for the nine fifth grade classes, and from these computed z scores on four classes to determine the probability that the two first grade classes and two fifth grade classes on which the analysis of the narrative data focused were representative, not outliers, in the samples of first and fifth grades.

Table 1 illustrates that within 95 percent confidence intervals, the first grade and fifth grade classrooms studied in the fall are not outliers. The z score for one classification of teacher behavior "Presenting Problems" was outside the 95 percent confidence interval of ± 1.645 for one first grade. All other z scores for the first grade data ranged from -0.023 to $+1.528$, well within the 95 percent confidence limits of ± 1.645 . Z scores for the category "Attention on No One" was above $+1.645$ for one of the fifth grades intensively studied in the fall. All other z scores for the fifth grade data ranged from -1.47 to $+1.61$, also within the 95 percent Confidence Interval of ± 1.645 .

(Table 1 here)

Results

Korean education was highly influenced by Confucianism and the Chinese culture during the period before 1910, by Japanese culture during the Japanese colonial period in Korea between 1910 and 1945, and by the Americans since 1954. But the Korean national educational system is structured very much like the national educational systems in China and in Japan. The American researcher in this study expected to find close congruence in Korean classrooms with classrooms in other Asian educational systems investigated and reported by others in previous studies. But Korean graduate students with whom we talked at the beginning of the study predicted that the findings of Stevenson and his group in Japan would not be found in Korea. The consensus was that, "Classrooms will be totally teacher centered. Teachers will be giving all the information, the students will be giving short answers recited from memory."

The results show that indeed classes are teacher-centered. Classes are organized in a large group with the teacher interacting with the whole class 97 percent of the time. Focus of attention is on the teacher 68 percent of the time in first grade classrooms, 39 percent of the time in fifth grade classrooms.² But we did not find that teachers merely spoonfeed information nor do students merely recite from rote memory. What we found in the intensive case study of one school were sequences of highly organized and systematic patterns of instruction, followed by short periods of practice and evaluation. That is, we found a pattern which can be described thus: Instruction/Practice/Evaluation or IPE, similar to the IPE patterns found in Japan (Lee, Graham, and Stevenson, 1996). In-depth analysis of the narrative data reveals that instructional and practice sequences were dominated by teachers' question/answer patterns which first directed students' attention to the knowns, to the critical parts of the problem, to the procedures needed to solve the problem, and often to the rationale for using the procedure. Further analysis reveals that teachers then use leading questions to guide students through the procedures using more and more complex and abstract examples. Students are required to give the answers, often in choral response. When individuals answer, the rest of the students are required to evaluate, in choral response, whether the answer is right or wrong. This repeated pattern, which we call TQ/SA/SSE (Teacher Question/Student Answer/Choral Evaluations of the student answer by other Students), seems to serve to keep most of the students consistently on task, and thinking through the procedures.

The classrooms we observed in Korea were dominated by Teacher Question/Student Answer sequences. Some of the questions solicited student explanation, but most were questions leading students through procedures to solutions of the problems. Students' choral responses and choral evaluation of other students' responses were also very noticeable in Korean classrooms. Choral responses were recorded in 36 percent of the timed segments measured. Figure 1 illustrates the salience of Teacher Questions/Student Answers, and the relatively low incidence of student explanations in response to questions found in the data. Teachers or other students evaluated other students' answers in 31 percent of the segments measured. Student evaluation of other students' answers was recorded in 15 percent of the

segments observed. Figure 1 also demonstrates the incidence of choral evaluations of student responses and of choral responses in general.

(Figure 1 Here)

In the Korean classrooms we observed, the topic of the lesson, and often the one problem, remain constant throughout the lesson. Materials and activities vary. Presentation of the problem becomes increasingly more complex and abstract. Mathematical concepts, particularly at the first grade level, are presented in every mode--verbal, concrete, and numerical. The lessons generally start with a word problem placed in a meaningful context. The same problem (in first grade) is then generally presented in many different forms and modes. In a typical first grade lesson, for instance, one problem was presented first as a word problem, then in equation form in a horizontal line, demonstrated with concrete pictures or objects, practiced by the students with manipulative counters at their desks, then presented in a number line, and finally presented with numbers placed in a vertical line. (A detailed illustration of one first grade mathematics lesson can be seen in the Appendix.) In at least 90 percent of the Korean mathematics lessons we observed teachers made use of concrete manipulatives, as well as verbal and numerical modes in presenting mathematical concepts. First grade teachers used concretes in 50 percent of the segments observed, fifth grade teachers in 36 percent of the segments observed. Figure 2 depicts the verbalization that is used with numerical and concrete modes for dealing with mathematical concepts in first and fifth grades in Korea.

(Figure 2 Here)

Practice and/or seatwork is usually assigned intermittently during the instructional sequences and evaluated immediately. Often children are instructed to check their answers in the answer book or to compare their answers with other children. Seatwork at the end of the class is generally limited to the last five minutes, and is monitored and evaluated. Coherence, (defined as having characteristics of connectedness, clarity, and movement from simple to complex) is generally highly evident in the lessons. Observers rated 60 percent of the classes observed as coherent, 40 percent of the first grade classes observed as highly coherent, 60 percent of the fifth grade classes as highly coherent.

The Instruction/Practice/Evaluation (IPE) pattern found in the data of the present study, the use of many modes--verbal, concrete, and numerical--to present problems, the location of meaningful problems in the real world, and the coherence and progression of the lesson from simple to abstract are characteristics Korean classrooms have in common with other Asian classrooms reported in the literature (Stigler and Stevenson, 1991; Lee, Graham, and Stevenson, 1996). We saw many instances of students' presenting their own problem solving and explanation to the class. However, it can be seen that mathematics instruction in Korean primary classrooms is not just like instruction in Japanese classrooms, where student problem solving and explanation is dominant. Nor is mathematics instruction in Korean primary classrooms like typical instruction in American classrooms, though we did find some instances of short instructional sequences with the whole group followed by a long period of individual seatwork while the teacher focused on individual instruction, typical of American classrooms.

What we found generally seems to be typically Korean, a focus on the teacher's leading questions guiding the whole class through the appropriate procedures in a most systematic way. The example of a mathematics lesson in one Pusan first grade classroom found in the Appendix exhibits the presentation of one problem in many different modes at varying levels of abstraction.

Characteristics of Korean Classrooms in the Context of Other Asian and American Classrooms

Because the present study utilized instruments developed for previous studies of Asian and American classrooms, analysis of the timed observations and the transcripts of the narratives and quantification of data from the coding instrument allowed us to make comparisons of the Korean data with data from Chinese, Japanese, and American classrooms. It is most useful to compare the structure of classrooms across cultures, particularly given the differences in mathematics achievement of Asian and American children, and the discussion one hears today about open education in Asian educational circles. Here we compare data from the case study of one Pusan school where four lessons were observed in each of four classrooms with data from other Asian and American studies. The instruction/practice/evaluation (IPE) pattern discussed in the results section above was seen in 100 percent of Korean mathematics classes we observed, higher even than Japanese patterns reported in Lee, Graham, and Stevenson (1996). The IPE pattern can be observed also in America (Lee et al, 1996), but to a much lesser extent, as can be seen in Figure 3. Figure 3 illustrates the percentage of lessons in Korea, Japan, and the United States that observers found to have repetitive patterns of instruction, practice, and evaluation. Data illustrating Japan and the United States are from Lee, Graham, and Stevenson (1996). The Japanese and American data are also reported in Stevenson and Lee (1995).

(Place Figure 3 here)

The repetitious Instruction/Practice/Evaluation (IPE) strategy is facilitated by organization of students into the whole class with the focus of students on the teacher or on other students. This study and earlier studies conducted by the Michigan group demonstrate that Asian teachers teach their classes in the whole class more than do American teachers where more emphasis is on individual learning. Korean teachers are almost entirely oriented to whole class teaching, though we did see some experimental classes in specific schools in which student desks were placed in such a way as to encourage group study. Figure 4 illustrates the organization of first and fifth grade classes in Korea, Japan, Taiwan and the USA. Illustration of Taiwanese, Japanese, and American data in Figure 4 are from previous studies reported in Stigler and Stevenson (1991), Stevenson, Stigler, Lucker, Lee, Hsu, and Kitamura (1987), and Stigler, Lee, and Stevenson (1987).

(Place Figure 4 here)

Korean teachers in our sample spent 97 percent of the time they were observed teaching mathematics teaching the whole class. This contrasts with the organization of many American classes where students are working alone while teachers work individually with children or on other tasks (Stigler and Stevenson, 1991). Very little small group teaching is utilized in the schools we observed except in one school beginning to experiment with what administrators termed "open education." In one class observed using the small group approach, the teacher spent the first twenty minutes of the lesson instructing the whole group, then, after giving a group construction assignment, worked with each group in turn at a central table for the remaining thirty minutes of the class period.

In mathematics classes in Korea, as in classes in Japan and China reported in previous studies (Stigler, Lee and Stevenson, 1987, Stigler and Stevenson, 1991), focus of students is on the teacher most of the time. Korean first grade students were in teacher led activity 68 percent of the time, focused on their own work (rather than on the class leader) 29 percent of the time. Fifth grade students were focused on the teacher 39 percent of the time. Fifty-two percent of the time fifth grade students were focused on their own work. Occasionally focus was on other students. Never did we see occasions in first grade mathematics classes where no one was in charge of the classroom. Table 2 illustrates the percentage of time we observed the focus of students' attention to be on the teacher, on other students, on the child's own work, or on no one in Korean classrooms.

(Table 2 here)

These data can be contrasted with data from Stigler, Lee, and Stevenson (1987) that show that American children spend only 46 percent of their time in teacher led activities due to the amount of time American teachers spend working with individuals and small groups. Figure 5 illustrates the percentage of time students in the four countries spent in activity led by the teacher and the percentage of time classroom activity was led by no one.³

(Figure 5 Here)

The most salient behavior of students in Korea was behavior characterized as attending to the teacher or the assigned task. The majority of the highly disciplined students in Korea were reported to be attending in 83 percent of the segments observed in first grades, 71 percent of the time in fifth grades. This behavior is no doubt facilitated by the dominant IPE patterns we observed and the patterns of teacher questions/student answers/other students' evaluations (TQ/SA/SSE) and the dominance of choral responses in the classroom. Such strategies are most useful in keeping student's on task.

In Figure 6 we have compared these data with data reported in previous studies on the percentage of time targeted children were coded as attending to the teacher or the task defined by the teacher in China, Japan, and the United States (Stevenson and Lee, 1995).

(Figure 6 Here)

Conclusions and Implications

Acknowledging that many factors much broader than classroom organization and behaviors are probably impacting achievement in mathematics among primary students in Korea, we can also draw some conclusions from this study about classroom structures and behaviors that suggest these factors, too, may be related to higher mathematics achievement in Korean primary schools. Data from the present study suggest classroom structures and behaviors are significantly different from structures and behaviors in American classrooms as found in other studies, similar to structures and some behaviors found in other Asian countries in those same other studies.

The salience of a teacher-centered whole class organization in mathematics lessons with highly organized systematic IPE (Instruction/Practice/Evaluation) patterns can be said to be typical of Korean classrooms observed for this study. Teacher behaviors are dominated by question/answer patterns and demonstration of operations in many modes and patterns which lead students through the procedures and conceptual development of the problem, at the same time facilitating student thinking. Student behavior is characterized by choral responses and choral evaluation of individual responses which keep students on task. Problems are placed in meaningful context in the form of word problems in almost every lesson, and concrete demonstrations or manipulatives are seen in every lesson. Entire lessons often focus on the development and presentation in many ways of a single problem in a simple to complex, and concrete to abstract progression, resulting in complete, coherent lessons. Classrooms are generally organized in the whole class during instruction, the practice of each step during instruction is monitored and evaluated on the spot. Lessons are fifty minutes long, independent practice by individuals usually limited to the last five minutes of the lesson.

Other characteristics in classrooms were noted which may also have implications for the on-task behavior and achievement of children in schools. Students from first grade to 12th grade have a vigorous recess every hour in Korea. The schools in which we observed structured fifty-minute classes with a ten-minute recess between every class. Every hour at the sound of the bell, the whole school erupts in a sound of joy, children have what appears to be an unsupervised recess on the huge playing field, some children are busy at tasks cleaning the room, the corridor, the lavatories. Children are given the responsibility of the environment, and there is no evidence of vandalism on the premises of any school we visited. What is significant here, is the physical release children have every hour which is not seen in American schools. Korean students seem to come into class each hour with a willingness (or perhaps tolerance) to sit down and get immediately to work. Thus, life in classrooms is very different from classrooms in American schools--for teachers and for students. These characteristics, too, may be worth investigating for their relation to achievement in schools.

Other characteristics in the schools were noted by the authors which may also be related to the systematic development of mathematics instruction by teachers, and the on-task behavior of children. Teachers are in school eight hours a day in Korea, but in front of students only three or four hours. Teachers have preparation time with other teachers in a common study room. A high value is placed on in-service professional development by teachers and administrators in Korea. In addition, a very high value is placed on education by

families. Historically, education has been viewed as the key to material and spiritual success in Korea. Fifteen percent of the GNP in Korea is spent on education. Less than half of that is spent by the government (Sorenson, 1994). The rest of educational funding is provided by families and private individuals who support a very large private institute industry in Korea that provides after school tutorial and supplemental educational services to Koreans of all ages. In addition, the schools do not have the full burden of meeting every child's need. In Korea, the family of a child who is not learning well is expected to provide the child with extra help.

Certainly these characteristics of family influences and the nature of the supplementary education industry that serves students outside the formal school day are all worthy of further study for their effect on student achievement. The authors of this paper have addressed only classroom structures and activities. There is much yet to be done.

(Appendix here)

Notes

The authors wish to express their gratitude to Harold Stevenson and Shin-Ying Lee at The University of Michigan Center for Human Growth and Development for their generous advice and counsel for this project, as well as for the use of the instruments developed for their comparative studies in Taiwan, Japan, and the United States. The authors thank also the administrators, teachers, and first and fifth grade children in five schools in Pusan, Korea, who were participants in this study.

¹Reliability for the Japanese and American studies for which the instruments were designed was ensured by training observers until they had "achieved at least 80 percent agreement with an experienced observer (Lee, Graham, and Stevenson, 1996, 160)." As in the Korean study reported in this article, observers for the Japanese/American study were local undergraduate or graduate students. Trainers were members of the research team (Ibid).

²An earlier draft of this article, presented at the Annual Meeting of the American Educational Research Association, Chicago, March 27, 1997, reported results averaging the fall and spring data, giving the four classes observed in the fall heavier weight than the 15 classes observed in the spring. For the present article, data were reanalyzed and equal weight given each of 19 classes observed, four in the fall, 15 in the spring.

³Data for Japan, Taiwan and the USA were derived from successive observations of single targeted students and teachers (Stigler, Lee, and Stevenson, 1987). Data for Korea were derived from observations of the whole class. Thus, for the present study, if the majority of the students were observed to be organized for whole class teaching, and focused on the teacher, then Whole Class and Focus on Teacher was recorded.

Appendix

Analysis of Observation 2113

Lesson consisted of at least four Instructional sequences composed of Leading Questions (LQ) with children solving and Teacher Evaluation. Lesson began with a preliminary drill, and then a meaningful word problem. The teacher drew students' attention to the known, and to the procedure needed through leading questions. The same problem was repeated throughout the lesson using the following *modes*:

Verbal: Yun-Ho has 24 pieces of paper and Young-Mi has 43 pieces of paper. How many pieces do they have?

Numbers : $24 + 43 =$ on the felt board.
and In response to teacher's leading questions as to how many
Fingers: tens and ones there were, children held up 6, then 7 fingers.

T. directed students with LQs to do the problem on desks with counters.

Concrete Manipulatives:

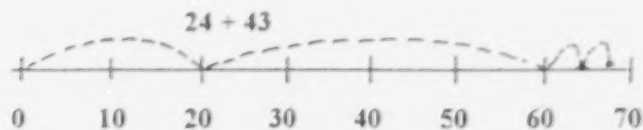


Numbers in Horizontal Format T. demonstrated addition of tens and ones on the blackboard thus, first adding the tens, then the single units:

First, the tens:	$\begin{array}{r} \boxed{24} + \boxed{43} = \\ \hline \end{array}$	$20 + 40 = 60$
Then, the ones:	$\begin{array}{r} \boxed{24} + \boxed{43} = \\ \hline \end{array}$	$4 + 3 = 7$

and then explained the tens and ones places.

Number line: The same problem was presented on a number line:



Vertical Format:

Finally the problem was presented in a vertical format:

$$\begin{array}{r} 24 \\ +43 \\ \hline \end{array}$$

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Table 1
Means and Standard Deviations for Observed Variables
in Ten First Grade Classes and Nine Fifth Grade Classes in Pusan,
with Z Scores for Four Selected Classes, Two First Grade, Two Fifth Grade

Observed Variables: Structures/Activities in Classroom	Ten First Grade Classes				Nine Fifth Grade Classes			
	Means	SDs	Z Scores for		Means	SDs	Z Scores for	
			Class 112	Class 113			Class 152	Class 154
Class Structure:^a								
Whole Class	98.90	1.23	-0.65	-0.21	95.71	7.67	-0.81	0.14
Small Groups	.29	0.90	-0.32	-0.32	3.94	11.83	-0.33	-0.33
Individuals	.86	2.71	-0.32	-0.32	3.25	6.87	0.96	-0.47
Attention on:								
Teacher	67.64	16.76	0.19	1.32	38.63	22.31	0.98	1.11
Another Student	12.58	13.87	-0.54	-0.12	15.33	13.52	-0.21	-0.28
Other Students	5.66	7.25	0.09	-0.12	9.18	18.45	-0.50	-0.39
Child's Work	28.80	12.56	-0.03	-1.05	51.66	19.35	-1.48	-0.45
No One	1.38	2.20	-0.34	-0.63	1.68	2.61	1.88 ^b	0.83
Teacher's Strategy:								
Orienting	3.73	3.33	0.78	-0.92	2.80	2.14	0.84	-0.11
Summarizing	2.16	3.05	0.33	-0.48	2.25	2.51	-0.64	-0.13
Presenting Problem	21.46	21.14	-0.60	1.95 ^b	10.56	10.61	1.30	0.76
Question/Answer	58.72	8.92	-0.84	0.74	29.48	14.97	0.93	1.50
Question/Explanation	4.11	5.08	0.56	-0.27	8.54	7.41	-0.62	-0.21
Directions	36.62	19.70	-0.93	-0.41	31.20	17.97	-0.05	0.83
Drill	29.44	26.01	-0.40	-1.13	18.42	22.05	-0.60	0.56
Mode in Which Mathematical Concepts Presented:								
Verbal	52.01	31.61	0.30	0.51	40.13	24.39	0.43	0.98
Concrete	49.53	24.25	-0.53	-0.47	36.58	40.41	-0.69	-0.52
Numbers	30.68	25.68	0.26	-0.43	19.62	27.12	0.30	-0.37
Student Activity:								
Attending	83.86	12.38	0.28	-0.40	75.28	25.95	-0.59	-0.46
Note-taking	0.00	0.00			2.22	6.43	-0.35 ^b	-0.25
Supervised Seatwork	18.15	13.07	0.16	-0.66	45.58	18.45	-0.65	0.03
Unsupervised Seatwork	.26	.83	-0.32	-0.32	4.90	8.44	-0.58	-0.58
Choral Response	43.53	16.97	-0.22	0.68	27.65	15.04	1.31	1.61
Off-Task Activity	1.21	3.60	-0.16	-0.34	2.64	4.91	0.00	0.24
Involvement of Teacher:								
Engaged	97.88	2.66	-0.87	-0.48	96.69	3.97	-0.05	-0.02
Disengaged	0.53	1.66	-0.32	-0.32	1.58	2.55	0.15	-0.37
Evaluations by:								
Teacher	18.16	11.96	0.18	0.47	13.71	11.89	-0.32	0.41
Other Child(ren)	20.03	14.92	-0.54	0.44	10.19	7.83	-0.54	1.56
Self	1.36	1.91	0.95	-0.71	4.28	4.40	1.42	-0.97

^aPercentages in each section do not add to 100 because more than one variable were coded in some of the timed segments.

^bIndicates z score for variable is outside 95% Confidence Interval ± 1.645 . Note: all other z scores are within the 95% Confidence Interval ± 1.645 , an indication that variables for classes 112, 113, 152, and 154 are not outliers in their respective first grade and fifth grade samples.

Table 2

Percentage time student attention is focused on Teacher, Students, Student's Own work, or on No One in Korean Mathematics Classes

	Teacher	Students	No One	Child's Work
First Grades	68	18	1.38	29
Fifth Grades	39	25	1.68	52
First/Fifth Grades	54	21	1.52	40

Teacher/Student Interactions

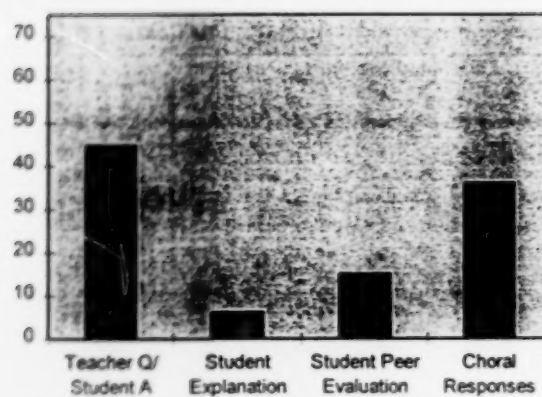


Figure 1. Percent segments in Korean classrooms in which teacher questions/student answers, student explanations, student evaluations of other students, and choral responses were observed.

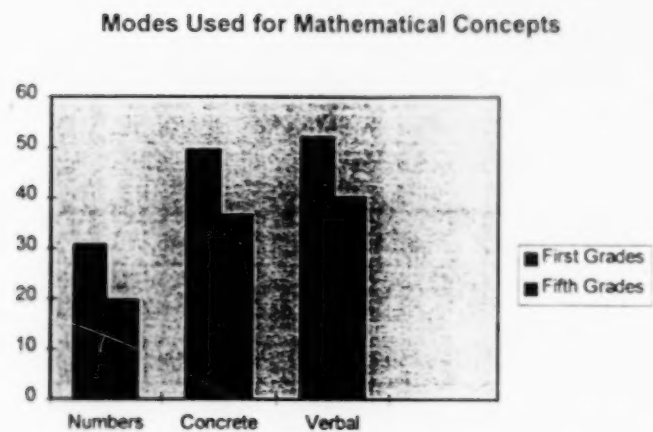


Figure 2. Percent segments in which numerical, concrete, and verbal modes used to explain mathematical concepts were observed in Korean first and fifth grades.

Instruction, Practice, Evaluation Pattern

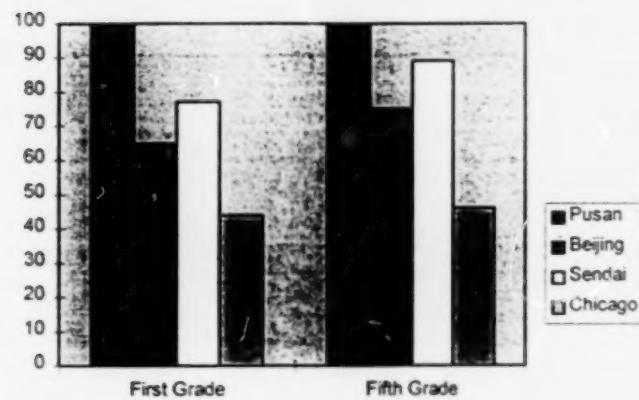


Figure 3. Percent of lessons observed containing sequences of instruction, practice, and evaluation.

Source of Pusan, Beijing, Sendai, and Chicago data: Severson and Lee (1995).

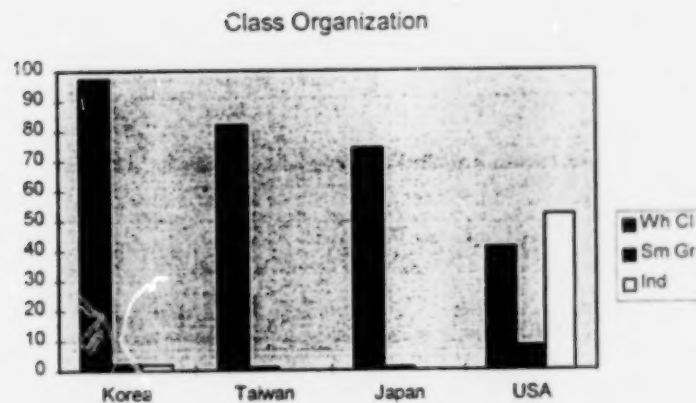


Figure 4. Classes organized in whole class, small groups or individually in Korea and four other countries.

Source of Taiwanese, Japanese, and United States: Stigler and Stevenson (1991), Stigler, Lee, and Stevenson (1987), and Stevenson, Stigler, Lucker, Lee, Hsu, and Kitamura (1987).

Focus on Teacher or No One

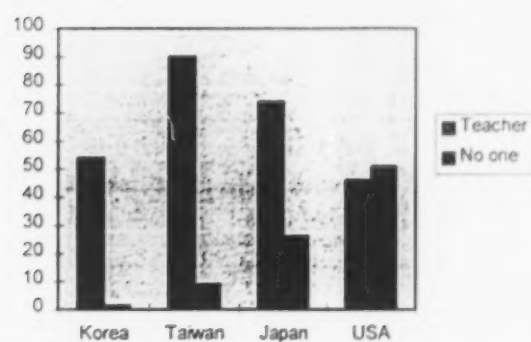


Figure 5. Percent segments students were observed in teacher led activities and in activities with no one in charge.

Source of Taiwanese, Japanese and United States data: Stigler, Lee, and Stevenson (1987).

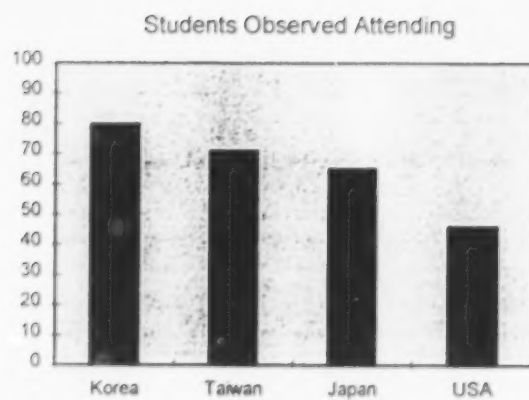


Figure 6. Percent of timed segments children were observed attending to leader of activity in four countries.

Source of Taiwanese, Japanese and United States data: Stevenson and Lee (1995).